Extreme Ultraviolet Emission via Plasma Counter-Injection

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Introduction

In order to understand how to better-generate intense LASER light in the EUV band, one must properly understand the nature of photon emission. As described in previous documents, photon emission is not the result of electrons leaping between energy states within electron clouds, but is rather the result of electrons within the same shell colliding with one-another, resulting in abrupt changes in the trajectory of an electron. These abrupt changes result in a reduction in the mass of an electron and its conversion into a photon. This mechanism has not been properly identified due to the infinitesimal length of time over which this occurs and due to the rapid replacement of the electron ejected from the system with a new electron, which is easily mistaken for the original electron.

Abstract

Current methods for generating EUV light involve the flattening of a droplet of tin using a LASER pulse, following that LASER pulse up with a more powerful pulse which renders the droplet as a plasma and then running a large amount of electrical current through the droplet along the Z-axis (known as a Z-pinch) in order to create a powerful magnetic field which both constricts and convects the plasma.

This generates powerful but brief pulses of EUV light and requires that new tin be rapidly pushed into the path of the mechanism. This is accomplished with a rotating disc so that with each attempt to flatten a droplet of tin, there is a high probability of success. The more intense and sustained the EUV light in photo-lithography, the more rapidly a computer chip can be manufactured and the greater the overall production output of a lithography machine.

Any plasma tends to generate a variety of frequencies of light including in the EUV band, however, in order for the light to be useful, it must be sufficiently intense. The tendency of extremely intense EUV to be generated by current methods is, unwittingly, the result of head-on electron-electron collisions.

When a flat plane of tin is rendered as a plasma and a Z-pinch is applied, the planar tin diverges into two planes which begin to, over an incredibly short timescale, bow outward, resembling an hourglass “)(.” These two curved lines double back until the mass of tin forms two complete circles which slightly overlap, resembling a Venn Diagram. As the separate lines meet up to complete the circles, this is where the electrons may collide with one-another and where EUV emissions occur. There is convection within each of these circles, which, before long, dissipates and the EUV emission drops off. In order to generate sufficient light of this intensity for lithography applications, the process must be repeated about 10,000 times per second.

Relative to the overall mass of the tin, the portion of the tin plasma which generates EUV is spatially small. What's more, the plasma is not re-used. The failure of physicists to correctly understand the nature of something thought to be well-understood such as photon emission has crippled this area of research.

A better approach would be to create an initial plasma and to sustain the plasma in a pair of adjoining compartments which are separated by a shutter. A powerful magnetic field would then be used to force the plasma from each compartment into the other and to force the plasma through a narrow channel so that the plasma from the A and B compartments must collide head-on, brushing past one another in order to complete a plasma exchange. If the plasmas can be pushed forcefully enough through a sufficiently narrow channel, the same sort of light-emission phenomenon can be generated more efficiently and with less variability in intensity over time, although the mechanism would still, most likely, be pulse-based as substantial magnetic energy is required to accelerate the plasmas sufficiently to achieve light emission in the EUV band. The frequency of the light emitted would depend upon the velocity of the counter-flowing electrons and the intensity would depend upon the plasma density. The tendency of the plasma to absorb its own emitted EM (undesirable for this application) would depend upon the proton density.

Conclusion

The ability to generate EUV light of greater intensity on a sustained basis can greatly increase semiconductor chip manufacturing throughputs.